OBSERVATIONS

ON

THE MUSCULAR TISSUE OF THE SKIN.

By JOSEPH LISTER, M.B. Lond. F.R.C.S.

Among the abundant new matter contained in those parts of 'Kölliker's Microscopische Anatomie' that are hitherto published, there is perhaps nothing more striking than the announcement that small bundles of unstriped muscle exist in all parts of the dermis that are provided with hairs, connected inferiorly with the hair-follicles, just below the sebaceous glands, and passing up obliquely towards the free surface of the skin.

The effect of the contraction of such little muscles must necessarily be to thrust up the hair-follicles and depress the intermediate portions of skin; in other words, to produce cutis anserina; and thus this condition, previously quite unaccounted for, received at the hands of Professor Kölliker a simple and beautiful explanation.

In March of the present year (1853) I made an attempt to verify this most interesting discovery; and although the somewhat arduous duties of a resident office in University College Hospital prevented me from making the investigation as extensive as I could have wished, yet I found myself able not only to verify, but in some slight degree to add to Kölliker's observations. And as the main fact of the muscularity of the skin had not previously, so far as I am aware, found confirmation in this country, I have been induced to publish my results in the hope that they may prove acceptable to the microscopical anatomist.

Kölliker originally described* these muscles of the skin as flat bundles of unstriped muscular tissue, from 1-120th of an inch to 1-75th of an inch in breadth, of which there appeared to be one or two in connexion with each hair-follicle: it seemed

* *Vide* Microscopische Anatomie, vol. ii. part i. p. 14.

probable to him that they arose from the superficial parts of the corium, and he had clearly seen them passing obliquely downwards to their insertion into the hair-follicles, close behind the sebaceous glands which they embraced. In his 'Handbuch der Gewebelehre,'* published in 1852, he gives in the text exactly the same account of these muscles, except that he no longer expresses any doubt regarding their origin from the superficial parts of the corium. He afterwards states in a note that these muscles had been very recently seen by two observers, Eylandt and Henle, both of whom, however, had found them narrower than he. Eylandt, who named them "arrectores pili," had never seen more than one bundle connected with each hair-follicle, and had failed to detect muscular tissue in the nipple and areola, and in the subcutaneous cellular tissue of the *scrotum*, penis, and perinæum, where Kölliker had described it as existing. Henle had traced the muscles to the most superficial parts of the dermis, where they divided into numerous little bundles 1-3000 of an inch in diameter, which could be followed to immediately beneath the epidermis; he had also seen muscular tissue in the nipple, areola, and the other parts where Kölliker had described it, but, on the other hand, in the opinion of Kölliker, he had gone too far, inasmuch as he described bundles of plain muscular tissue as existing on the exterior of the sudoriferous glands and blood-vessels of parts destitute of hairs (such as the palm and sole). These Kolliker is unable to discover, and he believes that Henle has been misled by the use of boiled preparations, in which, as Henle himself states, fine branches of nerves are liable to be mistaken for muscle. Thus it appears that the confirmation furnished by these two observers is by no means a very satisfactory one, and that Henle, the only authority on whom we rest for the fact of the muscles taking origin immediately beneath the epidermis, cannot, in the opinion of Kölliker, be implicitly relied on with reference to this investigation. It appears remarkable that Eylandt should have failed to discover muscular tissue in the scrotum, for the dartos was long since proved to owe its contractility to unstriped muscle. Of the parts in question I have examined only the areola mammæ, which, however, answered well to the description given by Kölliker, who states† that the bundles of muscle are there circularly disposed, forming a delicate layer in the deeper parts of the corium, and encroaching slightly on the subcu-

* *Vide* Handbuch der Gewebelehre des Menschen, p. 82.

† *Vide* Micr. Anat., vol. ii. part i. p. 14.

taneous cellular tissue. On dissecting a portion of an areola from the subcutaneous tissue towards the surface, I found on reaching the deepest part of the dermis a delicate pale reddish-yellow fasciculus circularly arranged; and a portion of this, teazed out with needles, and treated with acetic acid, presented in a well-marked manner the nuclei of plain muscular tissue. A camera-lucida sketch of a small portion is given on a reduced scale in Pl. VI., fig. 6.

In enumerating the parts where he has met with muscles connected with the hairs, Kölliker does not mention the scalp, probably because the density of the tissue of this part rendered it unfit for investigation by the method in which he prepared his objects, viz., isolating a hair follicle with its sebaceous glands and treating it with acetic acid. Its very firmness and consistence, however, make the scalp better adapted for fine sections than any other part of the skin; and as I succeeded better with sections than by the other method, the scalp has received most of my attention. By compressing a portion between two thin pieces of deal, and cutting off with a sharp razor fine shavings of the wood and scalp together, moderately thin slices may be obtained. Fig. 4 represents a perpendicular section made in this way, and treated with acetic acid; the epithelium has become detached from the free surface *a b*; *b c* is part of one of the muscles near its superficial attachment, and it illustrates pretty well the appearance presented by them under a rather low power. They are distinguished from the tissue around them by their transparent and soft aspect, and by the abundant elongated nuclei scattered through them. Under a higher power the characteristic "rod-shaped" nuclei become fully brought out, and no doubt remains as to the nature of the tissue. A good example of nuclei so magnified, derived from a muscle connected with a hair-follicle of the pubes, is shown in fig. 5. It will be observed in fig. 4, that the muscle has been traced to within a very short distance of the surface, where the nuclei became obscured by other tissues.

But I afterwards found that much better sections could be obtained from dried specimens. A portion of shaved scalp being placed between the two thin slips of deal, a piece of string is tied round them so as to exercise a slight degree of compression; the preparation is now laid aside for about twenty-four hours, when it is found to have dried to an almost horny condition. It then adheres firmly by its lower surface to one of the slips, and thus it can be held securely, while extremely thin and equable sections are cut with great facility in any plane that may be desired.

These sections, when moistened with a drop of water and treated with acetic acid, are as well suited for the investigation of the muscular tissue, as if they had not been dried.

Fig. 1 is slightly reduced from a camera lucida sketch* of such a section, made in a plane perpendicular to the surface of the scalp, and at the same time parallel to the sloping hairs. I find that such a plane always contains the muscles in their entire length, the reason of which will appear shortly. In this figure *d* is the corneous, and *e* the mucous layer of the epithelium; *b*, *b*, ... are the hair-follicles with their contained hairs, both have been more or less mutilated by the process of section; the second hair from the right being a short one, its bulb is seen: *c c* . . . . are the sebaceous follicles, also more or less mutilated: a_1 a_2 . . . . a_6 are the muscles, which appear, under this very low power, merely as transparent streaks, and require a higher power to make out their tissue. The muscles are seen to arise in all cases from the most superficial part of the corium, and to pass down obliquely to their insertions into the hair follicles immediately below the sebaceous glands. It will be remarked that the muscles are here all on the same side of the respective hair-follicles, viz. on that side towards which the hair slopes: and such I found in the examination of a large number of sections to be always the case. This is an interesting fact, as such an arrangement of the muscles is exactly that which is best adapted for erecting as well as protruding the hairs, which must be drawn by their contraction nearer to the perpendicular direction. That this erection as well as protrusion of the hairs does occur, I have proved by artificially exciting the state of cutis anserina upon my own arm and leg. Tickling a neighbouring part will often induce horripilation, and if the eye is kept on an individual hair at this time, it is seen to rise quickly as the skin becomes rough, and to fall again as the horripilation subsides. I have never seen more than one muscle to each hair-follicle in the scalp; and in order that a single muscle may by its contraction simply erect a hair, it must be placed in a plane perpendicular to the surface of the skin and parallel to the hair; this explains the fact before alluded to, that a section made in such a plane is sure to contain the muscles in their entire length if at all, while sections in other planes cut across either the muscles or the hairs.

Fig. 2 represents the superficial attachments of the two

* In all the sketches from which the figures that illustrate this paper have been taken, I have used the camera lucida, which instrument has the great advantage of ensuring correctness of proportions.

muscles a_1 *and* a_2 of fig. 1; *a* being the upper end of a_1, and *b* that of a_2; *c* is the corncous, and *d* the mucous layer of the epidermis; the intervening tissue between the muscles was omitted in the sketch to save time. *b* furnishes a good example of the subdivision of a muscle into secondary bundles near the surface, as observed by Henle, while in *a* the subdivision, if it has occurred at all, is certainly not carried so far: the muscle *b c* in fig. 4 seems not to have undergone any subdivision: in some cases a simple bifurcation of a muscle near the surface is all that is seen: hence the splitting up of the muscles into smaller bundles near their upper attachment appears not to be a constant thing, and when it does occur exists to a very variable degree in different muscles. Want of room in the plate has rendered necessary so great a reduction of the scale* from the original drawing, as barely to allow the nuclei of the muscles to be perceived; by looking closely, however, it may be seen that at *e* and *f* nuclei exist immediately under the epithelium, and before introducing them into the sketch, I ascertained, by a higher power, that they were really of the same character as those in other parts of the muscles. At *g* it was impossible to trace the nuclei so far; if any existed here, they were obscured by the fibrous tissue of the scalp, which adheres to the muscles throughout their whole length, but appears to form special sheaths for the bundles of origin at the surface, and these sheaths interfere considerably with the examination of the muscular tissue enclosed by them. In some cases, however, they seem to be prolonged beyond the point to which the muscular tissue reaches, acting as tendons of attachment, and this may perhaps be the case at *g*: I have seen one striking instance of this mode of attachment, where a muscle having divided into two portions at some depth below the surface, a pretty long band extended like a cord to the surface from one of the divisions, and acetic acid having been added, nothing whatever but yellow elastic fibres could be seen in this band (the white fibres had been of course gelatinised). As a general rule, however, the muscular tissue extends to within a very short distance of the epithelium, and often, as above stated, can be detected immediately beneath it, as Henle has represented.

In fig. 3 is shown the connexion of the muscle a_1, of fig. 1, with its hair-follicle; so that were the muscle *a* of fig. 2 continued far enough downward, it would join with *a* of

* Figs. 2, 3, and 4 have all been reduced one-half from the original sketches.

fig. 3. The hair and its follicle are seen cut across very obliquely: *b* is the hair, tilted somewhat out of its natural position in the inner root-sheath *c*; *d* is the outer root-sheath (corresponding to the mucous-layer of the epidermis), whose outer cells are perpendicular to the hair-follicle; *e* is the "structureless layer" of the hair-follicle; *f* is the circular layer of Kölliker; *g* the external longitudinal layer with which the muscle is seen to become blended. Several elongated nuclei appeared at g_1; whether these are derived from the muscle, which is evidently inserted a good deal into the part of the follicle that is hidden from view, or whether they are only the elongated nuclei that occur in all parts of the longitudinal layer of the follicle, is doubtful: their well-marked elongated character inclined me rather to the former opinion; *h* is a part of one of the sebaceous follicles, which appears to have no special connexion with the muscle that simply passes close by it without embracing it, as Kölliker implies, or sending any muscular expansion over it; and the same occurs in all cases, so far as I have seen; *i* is a portion of the fibrous tissue of the dermis, showing its connexion with the surface of the muscle.

Kölliker's description of the muscles of the skin (see p. 263) does not quite accord with what I have seen in the scalp, either as regards their shape or size. The muscles in this part had not, in sections parallel to their course, the appearance of flatness; and by cutting slices in the way above indicated, at right angles to their known direction, their transverse sections were readily seen, and proved to be often quite circular, sometimes somewhat elliptical or polygonal, showing their form to be that of more or less rounded bundles. Their average diameter is, according to my experience, 1-200th of an inch, which is less than half the average of Kölliker's measurements, but this discrepancy is probably due to difference of situation in the parts observed, Kölliker not having examined the scalp: for one muscle which I sketched from the pubes was very nearly 1-100th of an inch in diameter.

With regard to the statement of Henle, that muscular tissue exists in parts destitute of hairs, I have searched with diligence many good sections of both the palm and the sole, without having been able to discover any evidence of it on the exterior of either the sudoriferous glands or blood-vessels of these parts. In a section treated with acetic acid, the elongated nuclei of the internal coat of a small blood-vessel sometimes give it an appearance that might at first sight be mistaken for that of unstriped muscle; but this is an error easily avoided by care, and I cannot but agree with Kölliker in

thinking that, in some way or other, his boiled preparations have led Henle into error.

In order to verify Kölliker's statement* that no unstriped muscle exists in connexion with the vibrissæ of mammalia, I examined the feelers of a cat. These large hairs extend far down into the tissues beneath the skin, and have a more complex muscular apparatus than the small hairs of the human skin. Bundles of muscles extend from the lower part of the gigantic hair-follicle obliquely upwards to the inferior aspect of the skin, and, in addition to these, there is muscle surrounding the large nerve that enters the base of each hair-follicle. These muscles were all of the striped kind, but extremely soft and extensile, and among the fibres were a number of very elongated nuclei, but I saw no distinct evidence of the admixture of unstriped muscle.

In conclusion, I may state that this investigation has proved to me the general correctness of Kölliker's original observations, and also of the results of Henle's further inquiry, except in the case of the alleged muscularity of parts destitute of hairs; and I shall be happy if the little additional matter communicated in this paper shall be found to bear as well the scrutiny of others.

University College Hospital, June 1st, 1853.

* *Vide* Micr. Anat., vol. ii. part i. p. 15.

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ON THE EMBRYOGENY OF ORCHIS MASCULA.

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After the elaborate memoir of M. Tulasne on the vegetable embryo in the 'Annales des Sciences Naturelles' for 1849, containing not only the results of his own extended investigations, but embodying a complete analysis of all that has been previously written on this subject, it is with diffidence that I offer the following details, which are chiefly confirmatory of facts already elicited. The reviewer of Professor Quekett's Lectures on Histology in the first Number of this Journal, page 44, hints that "the question of the entrance of the pollen tube into the sac of the embryo" is *still* one of interest to vegetable physiologists; this remark has suggested the present communication.

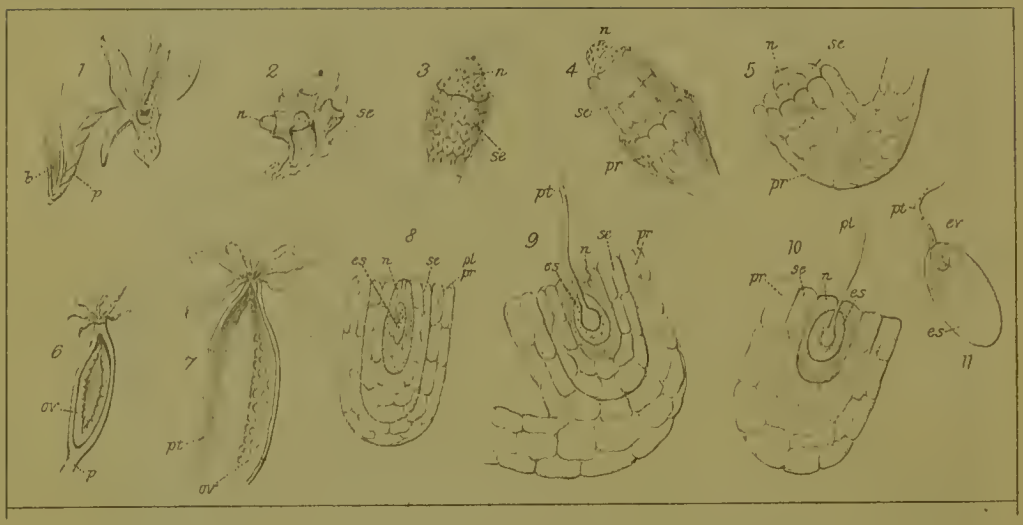
Of all the natural orders hitherto examined by the embryologist, few have been more closely studied or yielded more satisfactory results than the *Orchidaceæ:* the researches of Brown, Amici, Mohl, Muller, Hofmeister, and many others, are too well known to require recapitulation; our own inquiries have extended over a large number of *genera*, but the selection of a single species sufficiently demonstrates the question under consideration.

Referring at once to the illustrations, fig. 1. will be recognized as a floret of *Orchis mascula*, with the peduncle (*p*) and bract (*b*) attached. Before fertilization is accomplished, the peduncle (which encloses the ovarium) begins to enlarge, consequent upon the growth of the contained ovula. Plate II., figs. 2, 3, 4, and 5, indicate the successive stages of development of the ovula; their first appearance is only recognised by a slight bulging outward of the cellular parietes (placentæ) of the ovarian chamber, in the form of papillæ, which are the representatives of the nucleus of the perfect ovulum (marked *n* in all the figures). The mode in which the *primine* (*pr.*) and *secundine* (*se.*) are developed, and subsequently enclose the nucleus, is also well shown. Some time after impregnation has been effected, the condition of the ovary assumes the appearance seen in fig. 6, a section of which, slightly magnified, is given in fig. 7. Bundles of pollen-tubes (*pt.*) run along the inner side of the placentæ and terminate by short curves, entering the micropyles of the ovula (*ov.*); on the left side of the figure their distribution is well exhibited, the ovula being detached, and the pollen-tubes left pendant.

Examining the ovules at this stage, we now perceive a cavity in the centre of each nucleus; this is surrounded by a cell-wall, and constitutes the *embryo sac* (fig. 8, *es.*). In the interior of the *sac* granular matter exists in more or less abundance, being generally found thicker near the apex; but, whether or not distinct cytoblasts or embryonic vesicles exist prior to the contact of the pollen-tube with the embryo sac (as is indubitably the case in numerous other phanerogamia), is a point not fully determined. In those instances where we have witnessed the union of the pollen-tube with the embryo sac, the granular matter has usually been found collected together opposite the point of application (figs. 9 and 10), and, in one instance, three embryonic vesicles (*ev.*) were visible at the apex of the sac, the pollen-tube remaining firmly adherent (fig. 11). This latter observation, agreeing as it does with what we have ourselves observed in *Gesnerea*, and being also in accordance with the views advocated by all later authorities, we think we cannot better close this short paper than by drawing the following conclusions, which may be regarded as embracing the leading facts and particulars hitherto promulgated on this interesting subject:—

1st. That prior to impregnation the ovule contains an embryo sac. 2nd. That the embryo sac is commonly formed at the apex of the nucleus. 3rd. That in the interior of the embryo sac there exists a granular fluid or formative blastema. 4th. That the sac frequently protrudes beyond the exostome (ovule tube; Griffith, Dickie). 5th. That in the interior of the sac, prior to impregnation, one or more cytoblasts, or embryonic vesicles, are formed. 6th. That their formation takes place by the aggregation of molecules. (Amici, Meyen, Hofmeister.) 7th. That the cytoblasts, or embryonic vesicles, also contain a fluid more or less granular. (*Globulo-cellular cambium;* Mirbel.) 8th. That the pollen is always necessary for fertilization (apparent exception given by Smith in *Cœlobegyne ilicifolia*). 9th. That the pollen, when applied to the stigma, sends out one or more tubes (prolongations of the intine), which contain granular matter (fovilla). 10th. That in most cases the union of the pollen tube with the apex of the embryo sac constitutes the very act of impregnation. 11th. That the result of this union is the formation of an embryo. 12th. That this formation takes place either by the metamorphosis of one of the pre-existing germinal or embryonic vesicles, under the dynamic influence of the fovilla (acting catalytically?); or, as is more probable, by the union of the contents of the pollen-tube with that of a germinal vesicle, similar to what occurs in the conjugation of *Confervæ*.

Morph. Journ. Pl. II



DESCRIPTION OF PLATE.

On the Embryogeny of Orchis mascula, *by Dr. Cobbold.*

The letters indicate the same in all the figures:—*b*, bract; *p*, peduncle; *ov*, ovula; *n*, nucleus; *se*, secundine; *pr*, primine; *pt*, pollen tube; *es*, embryo-sac; *ev*, embryonic vesicles.

Fig.

1. Flower of *Orchis mascula* prior to impregnation.
2. }
3. } Stages of growth of ovula before the period of fertilization (mag. 200
4. } diamet.).
5. }
6. Condition of the ovarium and peduncle at the time of impregnation.
7. Portion of the same (mag. 2½ diamet.).
8. Fully developed ovule (mag. 200 diamet.).
9. }
10. } Mode of union between the pollen tube and embryo sac (figs. 9 and 10
11. } mag. 250 diamet.).

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